Peanut Hulls: Their Properties and Potential Uses

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By W. J. Albrecht[1]

ABSTRACT

Peanut hulls are already used for poultry litter, filler in artificial fireplace logs, and roughage in cattle feed. Potential additional uses, most of which have not been systematically investigated, are pet litter, mushroom-growing medium, carrier for pesticides and fertilizers, mulch, fuel, absorbent for molasses, fillers, dry-cleaner, absorbent for oil spills, anticaking material, floor-sweeping compound, foundry-sand component, sealant in oil-drilling muds, metal polish, and charcoal briquets and activated carbon. The principal advantages recommending hulls for many uses are high absorbency (a method for determining water absorption is given), chemical inertness, concentrated supply at shelling plants, and low cost. Their principal disadvantage, bulkiness, which results in high transportation costs, seems to limit their potential to the development of markets near the source of supply. Index terms: analytical methods, byproducts, peanut hulls, waste utilization.

INTRODUCTION

Approximately one-half million tons of peanut hulls are available annually as byproducts of shelling plants in the United States. Of these, 60 percent are produced in Georgia, Alabama, and Florida; 20 percent in Virginia and North Carolina; and 20 percent in Texas and Oklahoma. Accumulated hulls around shelling plants are a fire hazard, and many shellers dispose of them by continuous incineration. However, burning frequently produces a large quantity of smoke and fly ash, and shellers have been cited for polluting. Several markets exist for hulls, principally as roughage in cattle feed, poultry litter, and filler in artificial fireplace logs, but these uses do not consume the available hulls. Most shellers are interested in additional outlets that would yield a profit or break-even return. Over the years, a number of uses for hulls have been evaluated to a limited extent, but for reasons known and unknown, most of these applications have not resulted in significant permanent markets. Changes in technology and economics could well make some of these dormant uses viable today. In addition, new uses could be developed that would provide steady outlets.

The principal advantages of hulls that should be considered in new uses are their high liquid absorbency, chemical inertness, concentrated supply at shelling plants, and low cost. For most uses peanut hulls can compete with other agricultural waste materials, such as sawdust, woodchips, corncobs, and cottonseed hulls. Since all these materials are bulky and therefore expensive to transport, the distance of the user from the supply is important. Peanut hulls can probably be competitive with other waste materials when the supply is reasonably close to the user.

Our laboratory has previously reported results on the use of hulls for manufacturing artificial fireplace logs (Albrecht et al. 1973), on the chemical treatment of hulls to improve digestibility for ruminants (Barton et al. 1974), and on the performance of steers fed peanut hulls for roughage (Burdick et al. 1975). This report summarizes additional uses that

[1]Research chemical engineer, Field Crop Utilization and Marketing Laboratory, Richard B. Russell Agricultural Research Center, Science and Education Administration, U.S. Department of Agriculture, P.O. Box 5677, Athens, Ga. 30604.

have been investigated in our laboratory and comments on some unpublished applications that have surfaced from contacts with peanut shellers.

PROPERTIES

Chemical Composition

The chemical composition of hulls has been reported by Glasser et al. (1973), Lynch and Goss (1930), Govil (1960), and the National Academy of Sciences (1969) to be:

	Percent
Moisture	8–10
Crude protein (nitrogen × 6.25)	6–7
Fat	1
Crude fiber	60–67
Cellulose	35–45
Lignin	27–33
Ash	2–4

The total analysis does not approximate 100 percent because the crude-fiber assay includes much of the cellulose and lignin. The lignin is higher than in most woods, which contain about 20 percent. This probably contributes to the relatively slow degradation of hulls exposed to the weather. A small amount of residual nutmeat mixed with the hulls provides the fat and some of the protein. A variable portion of the ash is contributed by soil adhering to the hull.

Bulk

Broken hulls from the sheller have a density of 5 to 7 pounds per cubic foot; after milling through a ⅛-inch-diameter opening, the ground hulls weigh 15 to 17 pounds per cubic foot; when pelleted through a ¼-inch die, they have a density of 38 to 40 pounds per cubic foot. Since bulk is very important to the economics of transporting hulls, pelleting may be justified if the hulls are shipped a significant distance. In addition, pellets reduce storage-space requirements, are easy to handle, and eliminate the dust associated with ground hulls. Estimates of the cost of pelleting range from $5 to $10 a ton, depending on production volume. High tonnage favors lower cost primarily because of lower equipment-depreciation charges.

Absorbency

The water absorption of hulls is of prime importance in many applications such as poultry litter, pet litter, and carrier for aqueous dispersions of pesticides. Since there is no known standard method for measuring absorption of peanut hulls, the following method was devised: Five grams of hulls and 30 milliliters of water are added to a tared, 50-milliliter centrifuge tube. After centrifugation at 14,000 relative centrifugal force for 30 minutes, the excess water is decanted and the tube weighed. Absorption is calculated by the formula

$$\text{Absorption (percent)} = \frac{\text{Weight of wet hulls (grams)} - 5.00 \times 100}{5.00}.$$

The water absorption of hulls increases with reduced particle size. For example, hulls milled through a ⅛-inch opening had an absorption of 219 percent. After screening this same lot of hulls into four fractions, the absorptions were:

U.S. standard mesh	*Absorption (percent)*
+20	162
−20+30	197
−30+40	260
−40	307

Because hulls are used in the manufacture of range blocks for cattle feed, the absorption of molasses was investigated. Since it was not possible to effectively decant commercial molasses (50 Brix) from the centrifuge tube, absorption was determined with a 50–50 mixture of molasses and water. With the same hull fractions the absorptions were:

U.S. standard mesh	*Absorption (percent)*
+20	236
−20+30	263
−30+40	300
−40	436

The following water absorptions were measured for hulls from three varieties of peanuts. One variety was grown at two locations. All samples were milled through a 0.039-inch (16-mesh) opening.

Variety	*Location*	*Absorption (percent)*
'Florunner'	Georgia	231
'Early Runner'	Georgia	248
'Florigiant'	Georgia	290
'Florigiant'	Virginia	256

There was slight variation of absorbency with variety; however, there was also about the same variation in the 'Florigiant' peanut hulls grown at two locations.

Hulls also absorb organic liquids. In the manufacture of artificial fireplace logs, hulls absorb an equal weight of molten wax and can be compressed to a firm log. When burned, the hulls retain the molten wax in the log, preventing drip. Hulls also absorb an equal weight of tall-oil pitch, which has been used as a binder in making rigid peanut-hull pellets.

pH of Water Dispersions

The pH of a 5-percent dispersion of finely milled (less than 40-mesh) peanut hulls in water was 5.3. The addition of 0.7 milliequivalent of acid per gram of hulls lowered the pH to 2.3, whereas the addition of 0.2 milliequivalent of base per gram of hulls increased the pH to 10.0. This finding indicates that hulls have greater buffering capacity with acids than with bases.

Air Classification

When hulls milled through a ⅛-inch opening were fed into a baffled air column with an air velocity of 1,100 feet per minute, approximately equal weights of light and heavy material were obtained. The light fraction consisted primarily of the soft, white, inner liner of the hull, whereas the heavy, abrasive fraction was the outer portion of the hull. After these fractions were milled through a 0.01-inch screen, the water absorptions were: light fraction, 285 percent; heavy, 157 percent. The fine milling was used to eliminate particle size per se from the absorbency comparison. The textures of the two fractions were significantly different to the touch, one being gritty and the other, smooth. The absorption and texture differences in these two fractions could give them an advantage over unfractionated hulls in some applications.

POTENTIAL USES

Pet Litter

Retail sales of pet litter in the United States in 1977 were estimated at $50 million.[2] If we assume an average retail price of 15 cents per pound, these sales represent 170,000 tons of litter, or about 34 percent of the peanut-hull output.

In our laboratory we pelleted peanut hulls through a ⅛-inch die and then blended the pellets with 1 percent orange oil dissolved in hexane to facilitate blending. The pelleted hulls were then passed down a baffled airstream to remove fines, which are objectionable because they produce lumps when mixed with liquid waste.

A panel of 10 cat owners unanimously concluded that the litter was superior to the commercial litter they used. Acceptance of the litter by the cats, the absorbency of the hulls without caking, and the pleasant masking odor of the orange oil were given as the main advantages of the peanut-hull litter.

Hulls are currently valued at $20 per ton, or 1 cent per pound, while orange oil is about 30 cents per pound. Therefore, a pound of hull-orange oil litter can be made for 1.3 cents' worth of raw materials. This cost is probably competitive with litter products currently on the market.

Mushroom-Growing Medium

Our laboratory asked a Georgia mushroom grower to evaluate peanut hulls in his growing medium. After small-scale tests to adjust nitrogen in the medium, the grower developed a satisfactory mixture that contained no horse manure, usually a critical component of an acceptable mushroom-growing medium. Horse manure was difficult to obtain at certain times of the year and had to be transported at significant expense for several hundred miles, but peanut hulls were available year round at a distance of 50 miles. Using the hull medium for the past 2 years, this grower has produced the same yield achieved with horse manure, but at a significant savings. The prime attribute of hulls in mushroom growing, in the grower's opinion, is moisture retention. For this application it is desirable that hulls be exposed to the weather and partially rotted; therefore, covered storage for this use is unnecessary and even undesirable.

Carrier for Pesticides and Fertilizers

Hulls could make a satisfactory inert absorbent for pesticides and fertilizers. Pellets could be made from mixtures of hulls and the active ingredient. The active component would be slowly rain-leached, thereby prolonging its effectiveness. Dilution of active materials also makes uniform dispersion easier. At present, a peanut-hull pellet prepared in our laboratory containing 3 percent tall-oil pitch as a binder is being evaluated as a carrier for methaldehyde snail bait in California orchards. The objective is to produce a bait pellet that will resist disintegration in humid, wet weather for a prolonged period. Results of the test are unknown at this time.

[2] Private communication from Barbara Treleven, managing editor, Pet Supplies Marketing Magazine, Duluth, Minn.

Mulch

Mixing hulls with hard clay soil improves water percolation, whereas in sandy soil hulls improve water retention. Their relatively slow decomposition would prolong the beneficial properties of the mulch. Pelleted hulls could be used as a decorative mulch around flowers and shrubbery. Currently, investigations are underway in our laboratory to develop a water-resistant coating for pelleted peanut hulls. Such a coating would retard the disintegration of the pellets by rain, and extending the life of the pellet would make the mulch more appealing. Coatings of organic polymers have been applied to pellets by dipping them in hexane solutions of the polymer. To date, no coating has been found that will prevent pellet breakup after several hours' immersion in water. Efforts to develop a satisfactory coating will continue.

Fuel

Hulls make satisfactory fuel that has about 60 percent of the heating value of high-quality coal and only leaves 2 to 3 percent ash. If the user is near the supply, fuel can be an economic use. However, hulls as fuel probably have the lowest economic value of any use because of transportation costs.

Absorbent for Molasses

Ground hulls have been used as a carrier for molasses in animal feeds. Equal weights of molasses and ground hulls make a free-flowing solid at freezing temperatures, making it easy to blend molasses into feed mixtures in cold weather. In dairy-feed applications, pesticide residues in the hulls must be monitored because of the low pesticide tolerance in milk.

Fillers

Hulls have been used as fillers for plastics, concrete, plasterboard, and tile. However, no superiority over woodchips or sawdust has been noted, and there is no known use for this application today.

Drycleaner

There has been some interest in using hulls for drycleaning of fabrics and furs, but no visible market has developed. Perhaps a satisfactory drycleaning use can be developed with the light fraction from air-classified hulls (high absorbency, low abrasion).

Absorbent for Oil Spills

Limited tests have been made of hulls to absorb oil spills on water. No large-scale applications have been reported to date, but this use could develop into a large market.

Anticaking Material

A mixture of hulls and materials that tend to cake, such as fertilizers, could make a free-flowing product. Hulls are inert and inexpensive for this application.

Floor-Sweeping Compound

The absorbency of hulls makes them suitable for cleaning up aqueous or organic liquid spills and grease spots. Air classification of ground hulls would remove the fine particles that contribute to dustiness.

Foundry-Sand Component

Finely ground hulls were once tested as a component of foundry molding sand. Preliminary tests indicated that hulls in the sand produced a smoother casting, requiring less polishing. Probably the hulls were carbonized by the hot molten metal, creating a smooth surface. This application has not achieved commercial acceptance, but in view of the potentially large market, it should be worth further investigation.

Sealant in Oil-Drilling Muds

Our laboratory sent a sample of ground peanut hulls to an oil-drilling-supply company for evaluation. The company found the material unsatisfactory because of "souring" by microbial activity. Perhaps an inexpensive bactericide or fungicide mixed with the hulls could overcome this objection. Cottonseed hulls have been used for this purpose, according to the Encyclopedia of Chemical Technology (1965).

Metal Polish

Ground peanut hulls have been evaluated as an abrasive for polishing such soft metals as aluminum and copper. It is understood that these experiments were unsuccessful because the hulls were too abrasive. It is possible that this abrasiveness was the result of dirt adhering to the hulls. Possibly, air classification or screening of milled hulls would remove this dirt and make ground hulls satisfactory for polishing soft metals.

Charcoal Briquets and Activated Carbon

A university research project to produce these carbon products from hulls was reported at a scientific meeting some years ago. But no publication of the results or commercial utilization of this effort can be found at this time.

CONCLUSION

Peanut hulls will probably continue to be used in diverse ways because the supply is widely dispersed and transportation costs make it uneconomical to concentrate enough hulls for a large single-use operation requiring several hundred thousand tons a year. This leaves the development of markets where it has always been, mainly with individuals or groups of shellers in close proximity.

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